

## **BARRIER RIB MATERIAL FOR DISPLAY DEVICE**

### **FIELD OF THE INVENTION**

5           The present invention relates to a barrier rib material comprising water glass and an inorganic filler, and to a simple method of preparing barrier ribs in a display device using same.

### **BACKGROUND OF THE INVENTION**

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A liquid crystal display (LCD) or plasma display panel (PDP) unit has a discharge space maintained at a reduced pressure condition, which can be typically formed by seal-tightly attaching a front plate to a rear plate using an adhesive composition. A glass composition having a low melting point for the  
15       adhesion of a panel to a funnel of a CRT display is disclosed in Japanese Laid-open Patent Publication No. 2000-030614A. In this patent, a Pb-B<sub>2</sub>O<sub>3</sub> based glass adhesive is used to adhere the panel to the funnel by heating at 430 to 450°C for 30 to 40 min, and the laminated product is evacuated at 300 to 380°C to obtain a high vacuum of below 10<sup>-6</sup> torr. Further, Japanese Laid-open Patent Publication  
20       No. 2000-011929 discloses a preparing method of a vacuum fluorescent display (VFD), field emission display (FED) or LCD using such a glass adhesive having a low melting point.

However, such low melting glass adhesive contains PbO, which is harmful to the worker who handles the glass and to the environment.  
25       Accordingly, the development of a glass adhesive containing no PbO is required.

In this regard, Japanese Laid-open Patent Publication No. 1995-316398 teaches the use of a mixture of an alkylphenyl silicon resin as an organic binder and an inorganic filler at 200 to 400°C, but this adhesive material has the problems that the evacuating process cannot be carried out at above 380°C due to a low  
30       decomposition temperature of the organic binder and the alkylphenyl silicon resin

is costly.

A back-light unit for LCD has been conventionally produced by arranging pipe-type lamps in series, which makes the production process complicated. Further, an LCD back-light unit comprising spacers, which are also known as barrier ribs, is difficult to be scaled up because of its complicated preparing process. Accordingly, there has existed a need to develop a method of forming a barrier rib for a large scale LCD in a simple and economical way.

In case of a PDP device, there has been developed a method of preparing a barrier rib for forming a discharge space comprising spreading an inorganic adhesive paste containing a glass adhesive of a low melting point and an inorganic filler onto the entire surface of a glass substrate, sintering the spread paste, exposing the sintered paste in a given pattern, and sandblasting the pattern formed. However, such a method requires complicated process steps, and it is not directly applicable to an LCD due to the differences in the spacing and the structure of the barrier ribs and also in the operating principles between PDP and LCD.

### **SUMMARY OF THE INVENTION**

Accordingly, it is an object of the present invention to provide a novel barrier rib material, which can be advantageously used to form a discharge space in a display device.

Further, it is another object of the present invention to provide a convenient and simple method for preparing barrier ribs in a display device at a low cost.

In accordance with one aspect of the present invention, there is provided a barrier rib material for a display device comprising 15 to 50 % by weight of water glass ( $\text{Na}_2\text{SiO}_2$ ) and 50 to 85 % by weight of an inorganic filler.

In accordance with a further aspect of the present invention, there is provided a method for preparing barrier ribs in a display device comprising ejecting a composition for the barrier rib material on a glass substrate through a

nozzle to form a desired pattern of the barrier ribs on the substrate and drying the pattern of barrier ribs at a temperature in the range of room temperature to 200 °C.

In accordance with a still further aspect of the present invention, there is provided a liquid crystal display (LCD) device comprising the barrier ribs formed by said method.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

The above and other objects and features of the present invention will become apparent from the following description of the invention, when taken in conjunction with the accompanying drawings, which respectively show:

FIG. 1 : a view of the longitudinal cross-section of an LCD backlight unit comprising barrier ribs.

FIG. 2 : a schematic view showing the preparative procedure of barrier ribs using an ejection nozzle in accordance with the present invention.

### **DETAILED DESCRIPTION OF THE INVENTION**

The present invention provides a barrier rib material for forming a discharge space for a display device such as PDP and LCD, and the inventive barrier rib material is characterized by comprising water glass( $\text{Na}_2\text{SiO}_2$ ) and an inorganic filler, containing no low melting glass nor a binder resin. The inventive barrier rib material can be simply prepared by spreading a paste composition for the barrier rib material on a substrate via a nozzle and drying the spread paste at a relatively low temperature, and therefore, it can be beneficially used in forming a barrier rib or spacer in the mass production of a display device.

Specifically, the inventive barrier rib material comprises the water glass and the inorganic filler in amounts of 15 to 50 % by weight and 50 to 85 % by weight, respectively.

The barrier rib material may be formed from a paste composition comprising 20 to 80 wt% of a water glass solution containing a water glass in an amount of 60 to 90 wt%, and 20 to 80 wt% of an inorganic filler. If the content of water glass is less than the lower limit, the viscosity of the composition becomes excessively low and thus it is difficult to form a rib structure, while if the water glass content is more than the upper limit, the viscosity of the composition becomes too high to be dispensed from a nozzle.

The water glass uniquely used in the present invention is well known and commercially available. The water glass can be easily diluted by the addition of water, thus facilitating control of the viscosity and the concentration of the composition for forming a barrier rib. Further, it does not release any harmful materials during handling the composition.

Representative examples of the inorganic filler include alumina( $\text{Al}_2\text{O}_3$ ), zirconia, cordierite, silica( $\text{SiO}_2$ ), eucryptite and spodumen. The inorganic filler may have an average size in the range of 0.1 to 30  $\mu\text{m}$ . If the average size of the inorganic filler is less than 0.1  $\mu\text{m}$ , the dispersion of the inorganic filler is difficult and the prepared barrier rib easily cracks. Meanwhile, if the average size of the inorganic filler is greater than 30  $\mu\text{m}$ , the paste composition is difficult to spread on the glass plate because of its thixotropic property.

The barrier rib material can be simply formed on a substrate by ejecting the composition for the barrier rib material in a desired pattern of the barrier ribs through a nozzle and drying the pattern of barrier ribs. The drying may be conducted at a low temperature in the range of room temperature to 200 °C.

When the barrier rib material is employed to form a space between glass plates, it can impart a good sealing property, so it can be beneficially employed in the fabrication of barrier ribs or spacers for the discharge space of PDP, VFD, FED or LCD.

In addition, since the composition of the barrier rib material has a good adhesive strength, it may be used as a common adhesive, e.g., for adhering various glass panels.

The longitudinal cross-section of an LCD backlight unit comprising barrier ribs is illustrated in FIG. 1, wherein a rear glass plate 8 and a front glass plate 1 are adhered by a sealant 9 to form a discharge space 7 for an LCD; a reflecting plate 5 is positioned on the inside of the rear glass plate 8; barrier ribs 4 are provided on the reflecting plate 5; and the sealing paste 2 is filled between the top of the barrier ribs 4 and the front plate 1. Further, fluorescent substances 3 and 6 for emitting light in the discharge space are coated on the front plate 1 and on the inside of the reflecting plate 5, respectively.

Referring to FIG. 2, in accordance with the present invention, a barrier rib for an LCD can be prepared by spreading and drying the inventive paste containing water glass and an inorganic filler through an ejection nozzle.

As mentioned previously, the inventive paste composition for the barrier rib generates no volatile harmful materials in the working environment. Further, the preparation method according to the present invention has an advantage over the previous methods in that it can be conducted at a relatively low temperature of 200°C. Therefore, the inventive method can be utilized for the mass production of display devices such as PDP, VFD and FED etc.

The present invention will be described in further detail by the following Examples, which are, however, not intended to limit the scopes of the present invention.

### Example 1

60g of a mixture containing 70 wt% water glass and 30 wt% distilled water, 30g of alumina granules (ALM41, a product of SMITOMO, Japan) and 40g of a zircon powder having an average diameter of 8.0  $\mu\text{m}$  were mixed together to obtain an inorganic adhesive paste.

The resulting inorganic adhesive paste was spread to the entire surface of a 50 mm x 50 mm x 2.8 mm soda lime glass plate to a thickness of 2.5mm, and dried at 120°C for 30min. Then, the adhesive strength of the resulting

specimen was tested by applying shearing stress to the inorganic adhesive layer and determining the loading at which the layer is broken with a peeling force tester. The test result is shown in Table 1.

Further, as shown in Fig. 2, the inorganic adhesive paste **40** was applied  
5 to a soda lime glass **20** (a rear glass plate) in a pattern using a nozzle **10**, to provide a barrier rib **30**, and another soda lime glass (a front glass plate) having the same size as the rear glass plate was covered thereon, and the resulting laminate was dried for 30min. at 120°C to obtain a discharge structure for an LCD backlight panel. The discharge structure was heated to 380°C in a  
10 furnace and evaporated under  $10^{-7}$  torr and then subjected to a leakage test. The test result is also listed in the Table 1.

### **Example 2**

15 The procedure of Example 1 was repeated except that 30g of a mixture composed of 83wt% water glass and 17wt% distilled water, 52g of a zircon powder having an average diameter of 8.0  $\mu\text{m}$  and 18g of a  $\text{SiO}_2$  powder having an average diameter of 7.4  $\mu\text{m}$  were used to obtain an inorganic adhesive paste.

### **Example 3**

20 The procedure of Example 1 was repeated except that 30g of a mixture composed of 83wt% water glass and 17wt% distilled water, 25g of a  $\text{SiO}_2$  powder having an average diameter of 7.4  $\mu\text{m}$  and 55g of a cordierite fine  
25 powder having an average diameter of 3.0  $\mu\text{m}$  (previously made by mixing  $\text{MgO}$ ,  $\text{Al}_2\text{O}_3$  and  $\text{SiO}_2$  in a 2:2:5 molar ratio, sintering at 1400°C for 2 hrs, grinding with a ball mill and filtering with a screening of 150 meshes) were used to obtain an inorganic adhesive paste.

### **Example 4**

The procedure of Example 1 was repeated except that 30g of a mixture composed of 80wt% water glass and 20wt% distilled water, 50g of a zircon fine powder having an average diameter of  $8.0\ \mu\text{m}$  and 30g of a  $\beta$ -eucryptite fine powder having an average diameter of  $5.0\ \mu\text{m}$  (previously made by mixing  $\text{Li}_2\text{O}$ ,  $\text{Al}_2\text{O}_3$  and  $\text{SiO}_2$  in a 1:1:2 molar ratio, sintering at  $1300^\circ\text{C}$  for 2 hrs, grinding with a ball mill and filtering with a screen of 150 meshes) were used to obtain an inorganic adhesive paste.

#### Example 5

The procedure of Example 1 was repeated except that 30g of a mixture composed of 80wt% water glass and 20wt% distilled water, 42g of an alumina fine powder (ALM 41, a product of SMITOMO, Japan) having an average diameter of  $1.5\ \mu\text{m}$  and 32g of a  $\text{SiO}_2$  powder having an average diameter of  $7.4\ \mu\text{m}$  were used to obtain an inorganic adhesive paste.

#### Example 6

The procedure of Example 1 was repeated except that 30g of a mixture composed of 70wt% water glass and 30wt% distilled water, 60g of a zircon fine powder having an average diameter of  $8.0\ \mu\text{m}$  and 55g of a cordierite fine powder having an average diameter of  $3.0\ \mu\text{m}$  (previously made by mixing  $\text{MgO}$ ,  $\text{Al}_2\text{O}_3$  and  $\text{SiO}_2$  in a 2:2:5 molar ratio, sintering at  $1400^\circ\text{C}$  for 2 hrs, grinding with a ball mill and filtering with a screening of 150 meshes) were used to obtain an inorganic adhesive paste.

#### Comparative Example

The procedure of Example 1 was repeated except that a  $\text{PbO-B}_2\text{O}_3$

based low melting point glass powder was mixed with a cordierite powder as prepared in Example 3 in a 8:2 mix ratio by weight to prepare a control adhesive paste, and it was sintered at 430°C after being applied to the glass plate.



Table 1

		Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Comparative Example
Mixing ratio (wt%)	Water glass	70	83	83	80	80	70	Glass powder having low m.p. based on PbO-B <sub>2</sub> O <sub>3</sub>
	Distilled water	30	17	17	20	20	30	
Amount(g)		60	30	30	30	30	30	80(wt%)
Inorganic filler (g)	Al <sub>2</sub> O <sub>3</sub>	30	-	-	-	42	-	
	Zircon	40	52	-	50	-	60	
	SiO <sub>2</sub>	-	18	25	-	32	-	
	Eucryptite	-	-	-	30	-	-	
	Cordierite	-	-	55	-	-	20	20(wt%)
Adhesive Composition	Water glass (wt%)	37.5	26.2	33.8	23.1	24.5	20.8	
	Inorganic filler (wt%)	62.5	73.8	66.2	76.9	75.5	79.2	
Adhesion strength (kgf)		13.0	11.0	14.5	12.0	15.5	12.5	10.0
Sintering temperature (°C)		120	120	120	120	120	120	430
Leakage		x	x	x	x	x	x	x

As shown in Table 1, according to the present invention, the adhesive paste can be dried at a relatively low temperature of below 200°C to form a barrier rib, and the barrier rib thus formed has a high adhesive strength, good sealing property, therefore, it can be beneficially used in the fabrication of a planar LCD backlight, PDP, VFD or FED.

While the invention has been described with respect to the above specific examples, it should be recognized that various modifications and changes may be made to the invention by those skilled in the art which also fall within the scope of the invention as defined by the appended claims.